J. Anat. (2001) **198**, pp. 239–242, with 4 figures Printed in the United Kingdom

Short Report

Gluteus minimus: observations on its insertion

JOHAN WALTERS, MICHAEL SOLOMONS AND JOHN DAVIES

Department of Orthopaedic Surgery, Groote Schuur Hospital, and Department of Pathology, University of Cape Town, Cape Town, South Africa

(*Accepted 10 August 2000*)

ABSTRACT

In 17 adult and 3 full term fetuses the hip joints were dissected to expose the insertion of gluteus minimus. An attachment of the deep surface of the tendon as it passes over the hip joint capsule was found in every case. Histological examination of this insertion confirmed the presence of short intramuscular tendons firmly anchoring the tendon to the capsule. It is suggested that this attachment retracts the capsule during hip joint motion, thereby preventing capsular entrapment.

Key words: Hip muscle insertion; abductors; impingement syndrome.

INTRODUCTION

The anatomy of gluteus minimus, with specific reference to the insertion of its tendons described in the classic anatomy texts is either incorrect or deficient. All the 11 textbooks of anatomy reviewed revealed a deficient description of the insertion of this muscle (Hall, 1965; Anderson, 1978; Anderson & Agur, 1978; Wagner, 1982; Last, 1984; Moore, 1985; Bergman, 1988; Christoforidis, 1988; Williams, 1989; Pratt, 1991; Moseley, 1995; Moore & Agur, 1996). Observation of over 650 anterolateral approaches to the hip (JW), as described by Hardinge (1982), for hemi or total hip arthroplasty, led the authors to examine this muscle in more detail. It was found that during surgery gluteus minimus could not be separated from the underlying hip joint capsule after division of its distal bony insertion. To achieve this, sharp dissection from the hip joint capsule was required. Walters & Solomons (unpublished observations, 1997) in a preliminary cadaveric study, noted the presence of an additional attachment of gluteus minimus to the hip joint capsule. They found that in addition to its well recognised bony insertion, gluteus minimus has, on its deep surface, a constant and strong insertion of its muscle and tendon into the superior aspect of the capsule as it proceeds to its distal bony insertion. (Fig. 1 *A*, *B*). The only reference to this attachment appears in Bergman (1988), incorrectly, as an abberation. Walters proposed that this insertion is responsible for retracting the capsule during hip joint activity to prevent entrapment of the capsule.

The purpose of this study is to present a more accurate description of the relevant anatomy of gluteus minimus than is currently available in the literature.

MATERIAL AND METHODS

Twenty cadaver hips were dissected to expose gluteus minimus by removing the overlying gluteus medius muscle belly and tendon. The gluteus minimus muscle belly was then carefully elevated from its attachment to the outer aspect of the pelvis by blunt dissection, to the level of the hip joint capsule, where its deep muscle fibres were found to be inserted into the superior aspect of the joint capsule. The tendinous insertion to the anterolateral ridge of the greater trochanter, a continuation of the superficial aponeurotic layer, was then elevated and the tendon mobilised proximally. At the level of the joint capsule the posteroinferior edge of the aponeurosis and the deep surface of the muscle were found to be firmly attached to the capsule, necessitating sharp dissection to separate them from the capsule. Samples of tissue taken from

Correspondence to Dr J. Walters, Department of Orthopaedic Surgery, University of Cape Town, H49 OMB, Groote Schuur Hospital, Observatory 7925, Cape Town, South Africa.

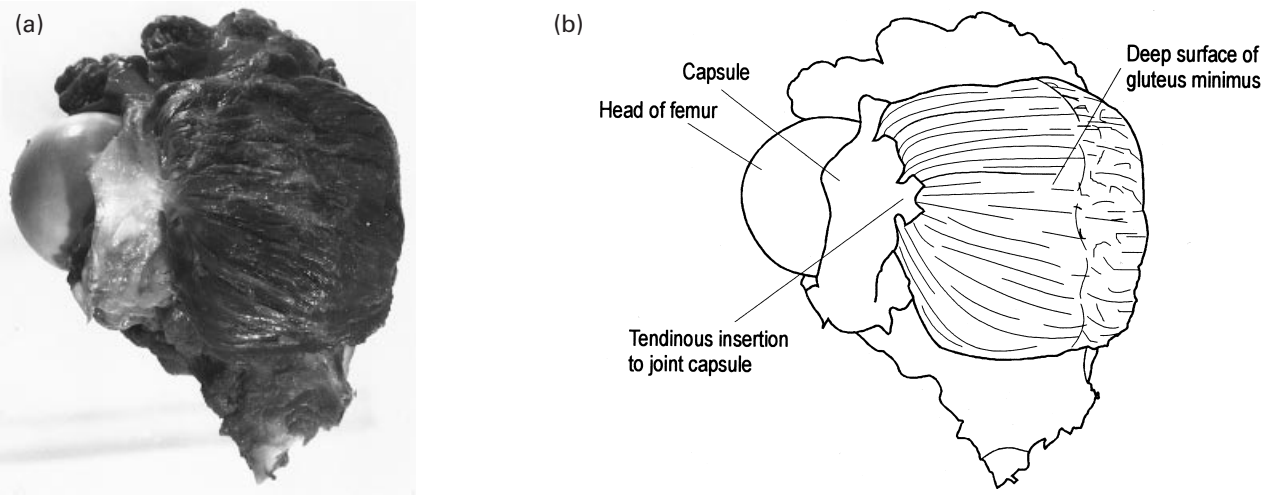

Fig. 1. (*A*, *B*) Excised right proximal femur, viewed from above. Gluteus minimus muscle belly reflected laterally exposing its deep surface.

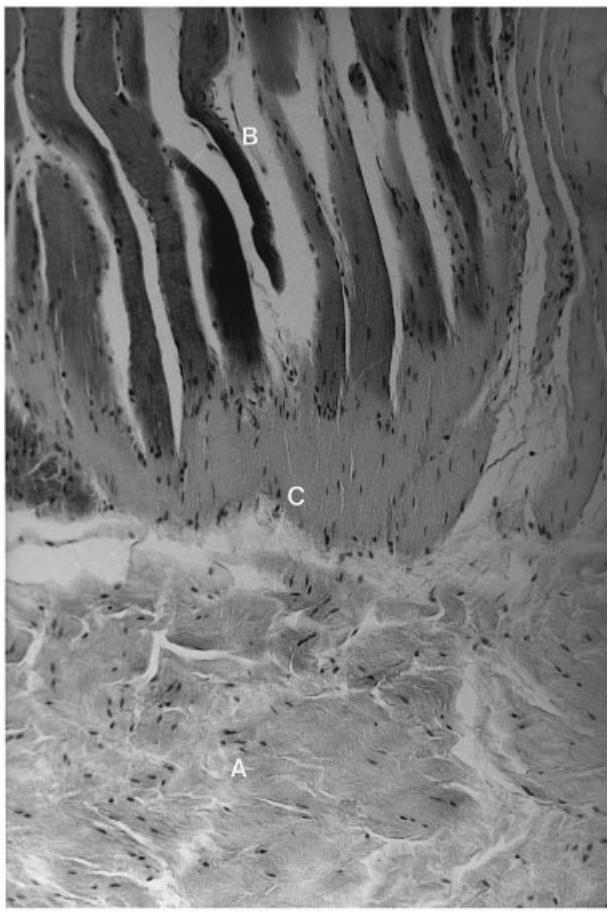

Fig. 2. Insertion of gluteus minimus into the capsule in an adult. Note the dense tendinous attachment. (*A*) Dense connective tissue of capsule; (*B*) striated muscle of gluteus minimus; (*C*) tendinous insertion of muscle into capsule. Haematoxylin and eosin, ×50.

the point where muscle and tendon were attached to the capsule were sent for histological examination.

The racial origin of the cadaveric specimens were as follows: of the 17 adults, 10 were male, 7 were female; of the 10 males, 6 were of mixed racial origin, 3 were Black and 1 Caucasian. Of the 7 females, 3 were of mixed racial origin and 4 were Caucasian. The average age was 54.5. The 3 full term fetuses were all black.

RESULTS

A firm attachment of gluteus minimus to the hip joint capsule, distinct from its distal insertion, was present in all dissection specimens. Histological assessment of the junction of muscle to capsule showed the presence of loosely oriented bundles of mature collagen, linking capsule to skeletal muscle perimysium, in all cases (20/20). In 14 of the 17 adult sections an irregular, but definite short tendinous junction was identified. Here striated muscle fibres were seen to become densely collagenous at the point of attachment to the connective tissue of the capsule. The dense collagen bundles were consistently arranged in a linear fashion at this point (Fig. 2). Of special interest was the presence of this insertion in all the term fetuses examined.

DISCUSSION

From these anatomical dissections it is apparent that the existing descriptions of gluteus minimus are incomplete. Of the 11 textbooks consulted, only 2 allude to an attachment of the muscle to the capsule. Gray's Anatomy (Williams, 1989) states that 'it converges below to the deep surface of an aponeurosis tapering to an anterolateral ridge on the greater trochanter with an expansion to the coxal capsule'. The implication here is that the tendon has a terminal expansion to the hip joint capsule and there is no mention of the deep 'muscular' attachment. Bergman (1988) states that 'detached slips may connect the muscle with the capsule of the hip joint'. Clearly this is incorrect as the capsular attachment is a normal

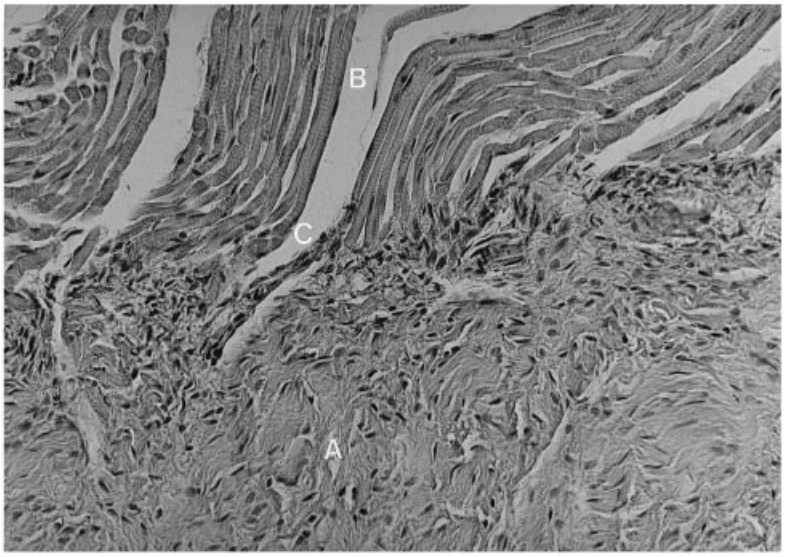

Fig. 3. Insertion of muscle to capsule in a term fetus. (*A*) Dense connective tissue of capsule; (*B*) striated muscle of gluteus minimus; (*C*) site of insertion of muscle into capsule. Haematoxylin and eosin stain, ×200.

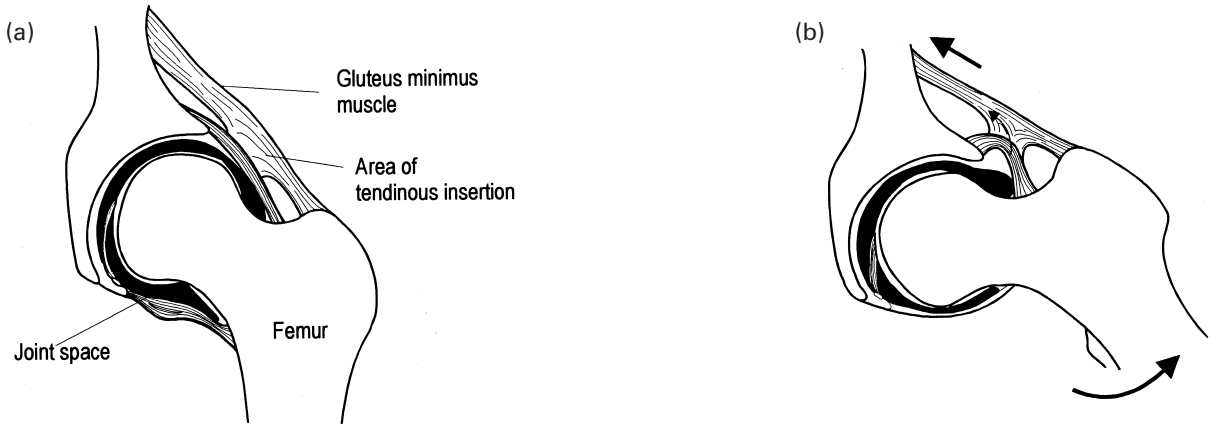

Fig. 4. Diagram of coronal section of the hip joint showing the attachment of gluteus minimus to the capsule (*a*), and its retraction during active hip joint abduction (*b*).

insertion and not a variation. On the contrary, the absence of this insertion would be variation. Histological sections of the junction of muscle fibre to capsule revealed the presence of well defined short intramuscular tendons in nearly all cases, confirming its insertion into the capsule. The inability to demonstrate the discrete tendinous insertion in 3 cases, where an irregular collagenous attachment was seen, may be due to inadequate sampling from the specimen provided.

The dense collagenous bundles at the junction to capsule, demonstrated on histological sections, were oriented in a linear fashion supporting the notion that they have (or had) a specific mechanical function.

The tendinous insertion was also demonstrated in the 3 fetuses and although the collagen bundles were not as well developed as in the adult specimens they were certainly present at birth and are therefore not an acquired phenomenon in later life (Fig. 3). There did not appear to be any difference in the findings between persons of African or Caucasian origin.

The descriptive anatomy of gluteus minimus should therefore include the following 'Gluteus minimus is a fan-shaped muscle lying deep to gluteus medius arising from the outer aspect of the iliac blade below the anterior gluteal line. Some muscle fibre converge to the deep surface of an aponeurotic layer which inserts into the anterolateral ridge of the greater trochanter with an expansion to the coxal capsule. Some deep fibres of the muscle insert into the superior aspect of the capsule as the tendon courses to its trochanteric insertion.'

The recognition of this insertion is important when performing the Hardinge approach successfully, as the tendon of gluteus minimus will be transected if it is not dissected free and retracted when the capsulotomy is performed. However, the more significant implication of the recognition of this insertion is to

ask the question, what is its function? Although not shown by this study, it is speculated that the purpose of this attachment is to ensure that the capsule is effectively retracted during hip motion (Fig. 4*a*, *b*). It is no accident that similar anatomical situations exist elsewhere, notably in the shoulder and knee joints but also the elbow and ankle and possibly others as well.

In the shoulder joint the rotator cuff muscles have attachments to the capsule demonstrating the very important dual function of not only stabilising and positioning the humeral head in the glenoid during motion but also ensuring that the capsule is effectively kept out of the way during such motion. Failure to achieve the latter will result in cuff impingement. Perhaps it is possible that similar impingement of the hip joint capsule may occur with muscle 'dysfunction' or dyssynchronous muscle activity (in particular muscle fatigue), and be the cause of unexplained hip pain associated with activity. Although not part of this study it is believed that other muscles around the hip joint may, like the shoulder, also have attachments to capsule.

REFERENCES

ANDERSON J, AGUR A (1978) *Grant's Atlas of Anatomy*, 7th edn, pp. 4–41. Baltimore: Williams & Wilkins.

BERGMAN RA (1988) *Compendium of Human Anatomic Variation*, p.23. Berlin: Urban and Schwarzenberg.

CHRISTOFORIDIS AJ (1988) *Atlas of Axial, Sagittal and Coronal Anatomy with CT & MRI*, pp. 448, 342. Philadelphia: W.B. Saunders.

HALL MC (1965) *The Locomotor System—Functional Anatomy*, pp. 34, 528–529. Springfield: Charles C Thomas.

HARDINGE K (1982) The direct lateral approach to the hip. *Journal of Bone and Joint Surgery* **64B**, 17–19.

LAST RJ (1984) *Anatomy—Regional and Applied*, 7th edn, p. 146. Edinburgh: Churchill Livingstone.

MOORE K (1985) *Clinically Oriented Anatomy*, 2nd edn, pp. 443–446. Baltimore: Williams & Wilkins.

MOORE K, AGUR A (1996) *Essential Clinical Anatomy*.. Baltimore: Williams & Wilkins.

MOSELEY HF (1955) *An Atlas of Musculoskeletal Exposures*, pp. 158–161. Philadelphia: J.B. Lippincott.

PRATT NE (1991) *Clinical Musculoskeletal Anatomy*, pp. 185–187F, 190. Philadelphia: J.B. Lippincott.

WAGNER M, LAWSON IL (1982) *Segmental Anatomy: Applications to Clinical Medicine*. Indianapolis: MacMillan.

WILLIAMS PL (ed.) (1989) *Gray's Anatomy*, 37th edn, p. 642. Edinburgh: Churchill Livingstone.